

\$20,000. Only one life was lost and five people injured. The low loss in life and property was due to three causes. The storm struck only rural sections throughout its course. It moved slowly, about 20 miles an hour, making it easy to get out of danger. It was visible for miles, and nearly everyone had watched it for at least 15 minutes before it struck. Word was also sent in advance by telephone.

The storm seems to have been due to conditions in the upper atmosphere, rather than unequal or extreme heating of the earth's surface. A check of the pressures, temperatures, and wind velocities reported from the stations surrounding North Platte revealed only slight differences. There was no hot wave before the storm; in fact,

the week preceding had been rather cool. Strong contrary winds were observed tossing the clouds at different levels before there was any sign of a tornado, while it was nearly calm at the ground. One observer said that it seemed to him as if a southwest and a northeast wind had met head-on overhead and started a whirl which began to enlarge and suck the clouds in toward it. The large number of funnels formed would indicate that a number of eddies existed in the upper atmosphere, but not all had strength enough to reach the ground. Some observers said that the tornado cloud seemed to consist of several layers at first. The make-up of the hailstones would indicate the presence of several levels of air with different temperatures.

## HAIL DAMAGE IN IOWA

By CHARLES D. REED

[Weather Bureau, Des Moines, Iowa]

Assessors in Iowa are required to ask each farmer on about 210,000 farms as to the amount of hail damage to crops on his farm the preceding crop season. These data are tabulated and summarized by the weather and crop bureau of the Iowa Department of Agriculture.

Eight years of these data are available at the close of 1930. In that period the average annual hail loss in the State was \$4,513,760, while the average value of the crops at risk was \$391,483,456. The greatest loss, \$7,975,686, was in 1925, and most of it occurred in the storm of August 18, extending from the southeast corner of Poweshiek and the southwest corner of Iowa Counties, almost due southeastward about 60 miles across Keokuk, Washington, Jefferson, and Henry Counties and into Lee County. The total damage in this storm was approximately \$5,000,000, making it probably the most destructive in the history of the State. The least damage was \$1,598,963 in 1930.

The greatest county damage was \$1,076,280 in Woodbury County in 1929, and the greatest township damage was \$321,380 in Liberty Township, Keokuk County, in 1924. The average number of townships reporting hail damage in the past eight years is 563, or 35 per cent of the total number of townships. In 1929, only 387 townships, or 24.1 per cent, reported hail, which is the least in the eight years, but the damage in these townships was rather intense, so the total was greater than in 1930.

Data are insufficient to work out definite zones of damage, but it now appears that the counties along the Missouri and Big Sioux Rivers and those adjacent are more subject to hail than other portions of the State, while a good many counties in southeast Iowa, particularly Davis, are nearly immune. In the 8 years, 24 counties had one or more years with no damage; 14, mostly in the southeast, had only 1; 4 counties, Dallas, Henry, Louisa, and Monroe, had 2 years; 5 counties, Des Moines, Jefferson, Lee, Van Buren, and Wayne, had 3 years; and 1 county, Davis, had 4 years without hail damage.

In the eight years, 159 townships, or about 10 per cent of the area of the State, reported no hail. It was found that in several cases considerable damage was reported by monthly crop reporters and others in some of these 159 townships from which the assessors reported no

damage. This discrepancy may be explained by the fact that crop reporters make their reports immediately after the storms occur, and at certain stages crops, especially corn, in a favorable season, have been known to largely recover from what at first appeared to be almost total destruction. Some months later when the assessor visits the farmer, the crop harvested is so nearly normal in yield that the farmer has forgotten all about the damage.

On the other hand, hail damage is so extremely localized, being large on one farm and amounting to nothing on an adjoining farm, that the actual acreage that escaped damage in the eight years is no doubt greater than the 10 per cent shown by using the township as a unit, and may be twice that amount.

It is recognized that the fluctuating values of crops of nearly equal quantity, or the inflation and deflation of the dollar, makes the dollar an unsatisfactory unit for measuring and comparing hail damage over a long period of years; yet it is convenient; a more complicated method might break down the cooperation of assessors and farmers; and eventually refinement may be effected by applying some commercial index number. The per cent of damage requires no such refinement. It is found by dividing the total damage (times 100) by the total value of crops at risk. In this 8-year period it averaged 1.15 per cent, the greatest being 1.99 per cent in 1925 and the least 0.50 per cent in 1930.

Further details are shown in the accompanying table.

Experience of hail insurance companies shows a larger per cent of damage than these figures indicate, for the reason that it is easy to write policies in a territory where devastating hail storms are of almost annual frequency, and relatively hard to write policies in a county like Davis, where damage is rare. The rates of the companies must therefore be basicaly higher and must, in addition, include the cost of getting the business, adjusting the losses, setting up reserves, maintaining offices and employees, and general overhead expenses.

If this line of inquiry is continued long enough, possibly when 20 years of data are available, a more satisfactory scale of county or even township rates for hail insurance may be worked out.

*Hail damage in Iowa*  
[Reported by township assessors]

Year	Damage and risk			Area of damage		Largest county damage		Largest township damage		Counties reporting no damage
	Total damage in State	Total amount at risk	Per cent of damage	Number of townships reporting damage	Per cent of all townships in State	Amount	County	Amount	Township and county	
1923.....	\$2, 319, 507	\$382, 987, 102	0. 61	451	28. 0	\$233, 336	Poweshiek.....	\$70, 094	Bear Creek, Poweshiek County.	Dallas, Davis, Des Moines, Dickinson, Guthrie, Jefferson, Lee, Louisa, Van Buren, Washington, Wayne.
1924.....	6, 903, 909	422, 087, 377	1. 64	598	37. 1	600, 259	Keokuk.....	321, 390	Liberty Keokuk County.	Monroe, Wayne.
1925.....	7, 975, 686	401, 371, 307	1. 99	748	46. 5	592, 800	do.....	189, 230	English River, Keokuk County.	Davis.
1926.....	2, 342, 187	355, 664, 129	0. 66	465	28. 9	415, 020	Webster.....	175, 225	Roland, Webster County.	Iowa.
1927.....	5, 064, 717	380, 753, 693	1. 33	664	41. 2	442, 305	Clinton.....	155, 150	Eden, Clinton County.	Davis, Dubuque.
1928.....	6, 363, 932	439, 206, 488	1. 45	779	48. 4	558, 966	Plymouth.....	189, 147	Magnolia, Harrison County.	Henry, Jefferson, Louisa, Van Buren.
1929.....	3, 541, 179	429, 093, 048	0. 83	387	24. 1	1, 076, 280	Sioux.....	203, 400	Lincoln, Sioux County.	Clay, Davis, Des Moines, Lee, Marion, Palo Alto, Wayne, Winnebago.
1930.....	1, 598, 963	*320, 704, 507	0. 50	410	25. 5	551, 818	Woodbury.....	83, 532	Liston, Woodbury County.	Clarke, Clinton, Dallas, Des Moines, Henry, Jefferson, Jones, Lee, Mahaska, Mills, Monroe, Van Buren.
Average.....	4, 513, 760	391, 483, 456	1. 15	563	35. 0	570, 098		173, 395		

\*Amount at risk, 1930, preliminary estimate, subject to change.

## MELON FROST FORECASTING IN THE UMPQUA VALLEY, OREG.

By EDGAR H. FLETCHER

[Weather Bureau Office, Roseburg, Oreg., April 27, 1931]

### INTRODUCTION

Since it occurs to the writer that forecasting frost for the benefit of commercial cantaloupe growing may be a rather new departure in the field of frost protection, a brief outline of the practical application of this service to the melon industry in the Umpqua Valley is presented, with special reference to the part played by fog formation.

### CONDITIONS FAVORABLE FOR CANTALOUPE PRODUCTION

The lowlands in the isolated valleys along the South Umpqua River in the general vicinity of Roseburg, Oreg., are being utilized for the growing of cantaloupes of superior quality. The three factors of primary importance—soil, temperature, and moisture—upon which the successful growing of cantaloupes depend are properly correlated here to produce quality and quantity.

The soil of these bottom lands is of silty loam, from 10 to 15 feet deep on gravel through which the river runs, and with a water table so high as to preclude the necessity of irrigation. The vines root down 5 or 6 feet and depend on subsoils moisture, which is supplied by generous winter rains, the summer season being almost rainless. Thus the unirrigated growth, together with the long growing season of cool nights and warm days, not only develops an extremely high sugar content but improves the flavor and keeping qualities, so that melons can be picked fully ripe for shipment almost any distance. The best and finest flavored crops are grown in the years when no rain falls from the time of germination to the end of harvest.

### FROST PROTECTION NEEDED

The harvesting season begins about August 15 and continues through the greater part of October. But there is the ever-present danger of frost during the second half of this period; and since it is in the second half that all the growers' profits lie, it stands the grower who wishes to safeguard his season's labor and results therefrom well in hand to consider some method of frost control, especially since the vines will continue to produce until killed by frost.

Experiments, though somewhat crude, in the fall of 1929 clearly demonstrated the fact that frost-control work can be successfully and profitably accomplished on late-maturing melon fields. It occasionally happens that an early fall frost occurs when a large portion of the crop is still unmaturing. To protect against a single September frost may be the means of prolonging the growing season for two or three weeks, and just at the time when the market is becoming more favorable. After the coming of the fall rains there is usually sufficient soil moisture to produce fog in the early mornings on radiation nights, thus affording a natural protection against frost damage. But frost hazard is great under any barometric condition with low atmospheric moisture and clear nights.

### EFFECT OF WIND

The wind movement, being extremely light in these more or less inclosed valleys, is not usually an important factor to be considered; neither is air drainage, as the valley surfaces are nearly level. However, a change in wind direction during the night to northerly or easterly has the effect of lowering the dew point and consequently preventing the formation of fog which may have been indicated at 5 p. m., especially if clearing does not occur until after that hour.

### FOG AN IMPORTANT FACTOR

An essential prerequisite to frost and minimum temperature forecasting in this region is the foretelling of the occurrence of morning fog, together with the degree of density, and the approximate hour of beginning, since occasionally there will be some damage before the fog begins to retard the fall in temperature.

Fog conditions can be determined with great accuracy from the 5 p. m. dew point and relative humidity in connection with the chart shown in Figure 1. This chart shows under what values of 5 p. m. dew point and relative humidity fog has occurred on radiation nights for the fall season at Roseburg during the past 22 years when the minimum temperature was 40° or below. In using the chart, if the hygrometric values fall to the left